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In commencing a new volume it may not be amiss to refer to the labors of another year, and to throw out a few hints as to what may be expected as matter of interest and discussion. The difficulties consequent upon the commercial embarrassments of the past year, have retarded, for a time at least, the progress of internal improvement. While the delay is but temporary for all useful and necessary public works, it will have the effect of bringing about a more cautious examination of projected improvements than has hitherto prevailed. A stricter estimate of the resources of proposed public works will hereafter be required, and we conceive that Mr. Ellet has done the profession a service in giving to the public his "Laws of Trade," being the first attempt to reduce to rules and fixed laws, a class of computations hitherto made with the utmost latitude of conjecture.

The difficulty of procuring funds, while operating to the permanent obstruction of injudicious projects, will require much economy in the management of those based upon more solid foundations than mere paper revenues. The assistance of the State authorities becomes more than ever necessary, but before granting this, a very important question has to be settled. Shall the State adopt one or two works and thereby be deprived of the power of giving aid to any other works? The question has been freely discussed in the public prints, and is now very nearly separated from party considerations. There can be no doubt that the best results have been attained where a *complete* and extensive system of public works, has been definitely arranged before commencing. Belgium affords a fine example of this. Now, it is impossible with us, for State governments to accomplish such a task with their own resources. How, then, shall the enterprise of individuals or companies be assisted by the State, without defeating the formation of a connected system of improvements? Obviously by the formation of a State board of public improvement, who, discarding exploded notions in regard to canals shall be able to mould out of the various individual projects asking aid of our legislature, such a system as shall satisfy all

the wants of the community, and who shall apportion the aid of the State in such manner as to best forward improvement throught the State.

An evil long existing with us will reappear with increased magnitude upon any revival of professional business. We refer to the want of organization and co-operation among engineers throughout our country. The benefits resulting from a proper *esprit de corps* are entirely lost, and one of the most considerable of these is a greater respect and dignity for and in the profession as a *profession*. There is hardly a class of men in our country containing more respectable and better educated members, and yet as a class they may be said to have no character or standing other than in their individual capacity. The engineers of Europe take rank among the men of science of the day, while the profession with us, scattered over an immense extent of country, possessing a vast fund of experience and information, and enjoying all the advantages of scientific education, have no mode of intercommunication, and no method of giving to the world the results of their labors. We have often endeavored to induce our professional friends to favor us with communications upon the subjects of their various experience—but with a small number of exceptions, we have found that distance, employment, or want of stimulus have prevented them from complying with our wishes. We however, will not let the present opportunity pass, without expressing our warmest thanks to such of our friends as have furnished us with many very excellent papers.

We conceive that much, if not all, of this indifference to commit to paper, the valuable information known to exist, would disappear under the influence of a proper organization of the Profession in the most liberal manner, and with a strict regard to its scientific reputation.

That we are not mistaken in the value and amount of matter that might be accumulated, we infer from the labors of the Chev. de Gerstner. It is understood that this distinguished gentleman has in his possession such a mass of detail, in regard to our public works, as would in itself, constitute a complete body of engineering. This has been entirely collected by the Chev. de Gerstner, or his assistant, who have in person visited every known railroad in the world. It appears that the impression made upon these gentlemen, by an inspection of our railroads, is most favorable, and far more satisfactory than had been anticipated. We have great faith in the confidence in our railroads, which this testimony will inspire both here and abroad—as well as in the respectable standing which it will give the Profession with those previously unacquainted with its labors.

One of the difficulties complained of in this, and in every other attempt to collect railroad statistics, is the loose manner of keeping accounts, which are correct enough as regards the aggregate of expense and income, but which do not distinguish and separate those items which should be carefully understood, in order to have an economical management of the affairs of a company. This indeed is a fault which belongs rather to companies and

their agents, than to Engineers, but a remedy might soon be found by a well directed professional body.

The past year has witnessed a new era in our history, the exportation of locomotive engines, to various parts of Europe, and above all, to England. We well remember the ridicule and sarcasm bestowed upon the first accounts of the performances of locomotive engines, which had accomplished more than was possible, according to calculations based upon some of the most antiquated experiments upon the subject. Now, however, the matter stands differently, and we cannot but confess, that we feel no small satisfaction in having at least aided in the dissemination of the truth of a matter having so important a bearing upon our domestic industry.

In the last place, we beg leave to add a few words in regard to ourselves. During the last year, we have suffered in common with the cause of improvement, and in self-defence have been obliged to adhere more strictly to our rule of payment in advance. We conceive that the loss, from our list of non-paying subscribers, will prove a *profit* to those who do pay, as well as to ourselves.

No one conducting a public Journal can satisfy every one; we have endeavored to do our best, and though sensible of some imperfections, we do not pretend to please all kinds of tastes, and have only to say, that if Engineers wish to see less of other men's work and more of their own, a very easy remedy is to be found. *Send us something of your own.*

As to those who desire us to exclude all matters pertaining to locomotive engines, etc., or any other particular branch of inquiry, we beg to assure them, that we shall do no such thing. We conceive that great injury has been done to the Profession by too close restriction, and we certainly cannot consistently curtail our list of subjects, though we will at all times be thankful for any suggestions of our friends.

We have made additional endeavors to increase the value and variety of our matter, and hope to give satisfaction throughout this volume.

We promised in the last number, to take up the subject of the railroad through the southern tier of counties, and now redeem that promise by offering our opinions on the claims of the southern counties, and by frankly stating the reasons which we consider sufficient to justify us in differing widely from the views and wishes of a large majority of the friends of this project.

Were the question an open one, we should be disposed to follow the example of Connecticut and leave all to private enterprize *unaided* by loans or grants from government; but by the construction of the Erie canal, the central counties were rendered populous and rich, and the emigration, which, without that channel, would have filled the northern and southern portions of the State, was turned off to the far west. One of the effects of this canal has been to bring the northern part of Ohio, a large portion of Michigan, and even Chicago nearer to the city of New York than millions of acres of

good land in this State, which are still as wild as when the country was first explored, and which would now have been nearly as well settled as the central counties, if the canal had not been constructed.

We do not mean it as the slightest objection to the Erie canal, when we say, that we believe the population of this State would, at this moment, have been much greater had that work never been undertaken. The experience of the last 15 years shows, that the country which contributes to the revenue of the Erie canal, and which is consequently benefited by it, consists of a belt of land on each side, averaging about 30 miles in width, and the official returns also show, that this State has furnished nine-tenths of the business of the Erie canal up to this period.

Now, the Erie canal is a work as general in its character as any undertaking of the kind can well be, yet, beyond a distance of 25 or 30 miles, its *beneficial* influence ceases, and it is notorious, that it has been the means of retarding the advancement of the southern and northern counties by offering every inducement to the husbandman to leave his native State, because it costs less to send his produce to market from Ohio and Michigan than from nearly one half of the State of New York. The western States offer great natural inducements to settlers, and it would be as unfair to *them* to attempt to check the tide of emigration as it is unjust to our own citizens to use indirect but most powerful means to retard the settling of *our* northern and southern counties. The views of our legislators appear to be too enlarged to be confined to their own State; and we would respectfully, but earnestly ask, Has the government of New York the *right* to tax her citizens in order that the property of the inhabitants of *other* States or Provinces may be carried to and from the seaboard more cheaply than at present rates? Not only is the N. York farmer to be taxed, but the amount so levied is to be expended in reducing the value of his property by adding, at his cost, great artificial to the already superior natural advantages of the west, and thus enabling the inhabitants of that region to undersell him in his own market. The entire course of New York legislation for many years appears to have had in view nothing higher, than to direct the energies and resources of government towards aiding the interests of forwarders and brokers at the expense of the farmer, the regular merchant and the mechanic, who require no exclusive privileges to enable *them* to carry on their business. Thus, the idea that the enlargement would bring to the Erie canal a few thousand more tons of freight, and lead to the sale of a few additional bales of goods, has been considered of more importance than to double the population and wealth of the State in ten years, by developing the resources of the northern and southern counties; and large sums of spare capital which would have been invested in internal improvements in *this* State, have been forced to the western and south western States to be expended on *their* improvements by placing the *at present*, comparatively trifling security of new States on an equality with that offered by the wealth and industry of Massachusetts and New York.

As yet all the means of the State have been spent on the Erie canal or its auxiliaries, and though we fully admit that the latter are of no use to the inhabitants of the central counties or to the Erie canal, because the tolls received on the lateral canals and consequently their contributions to the Erie canal are nominal—we shall still find that these large sums of money expended with that extravagance which appears inseparable from government works, do much to enrich these counties already placed in advance of the rest of the State, by the advantages conferred on them by the Erie canal.

What number of channels will it then require, to place the rest of the State on the same footing as the canal counties? "If we take a map of the State of New York, and suppose to be shaded or covered with paper, the country for 30 miles on each side of the Hudson river, of the Erie and Champlain canals and of the southern shore of lake Ontario as far as Ogdensburgh, we shall find that there are only two parts of the State where works of a *general* character can be projected—the northern part of the State and the southern tier of counties. These works would, like the Erie and Champlain canals, have resources of *their own*."—*Courier and Enquirer*, 7th May last.) Other important works may be pointed out in various parts of the State, but they differ entirely in character. The Albany and Buffalo, and the Albany and Whitehall chains of railways, are required in *addition* to the present excellent, though insufficient accommodations, of the Erie and Champlain canals; the Albany and New York, and Long Island railroads are to increase the present facilities offered by the navigation of the Hudson and of the Sound; but the channels opened in the northern and southern counties will form their *first*, their *only* direct communication with the city, and must serve for the river, canal, and railroads of more fortunate districts.

If it be the intention of the legislature to pursue the system of internal improvement, either by constructing works themselves or by aiding private enterprise, these portions of the State present not only the strongest, but the *only* just claims, *until* they are placed on an equal footing with other parts of the State, and *then*, if the revenue accumulate so fast that it cannot any longer be disposed of so as to confer *some* benefit, other than that arising from the mere expenditure of money in a certain district, the plethora may be rapidly and permanently reduced by the application of 'lateral canals', to which they have proved themselves admirably adapted, and which is in fact their legitimate function.

We have thus far endeavored to show, that the claims of the southern counties are equal to those of the central counties, consequently we fully acknowledge the *justice* of the adoption of this road by the State, but we feel confident that their *permanent* interests will be better served by constructing it with the *aid* of the State even at considerable expense on their part.

In the first place, a private company can, beyond all doubt, construct and put into operation a single track, for about 20,000 dollars per mile, or, say

in round numbers, ten millions of dollars for the entire work. The Philadelphia and Columbia railway, owned by the State of Pennsylvania, cost 40,000 dollars per mile, and to make the southern railway in a style corresponding with the new works on the enlargement, would require at least 60,000 dollars per mile, or nearly 30 millions of dollars. Railroads executed by private enterprise have cost this sum per mile, and the State must pay much more. The first cost cannot be put down at less than double, and the interest must be paid by the southern counties, in the shape of tolls.

Secondly, the time required will be double on account of the additional cost, besides a year or two which will be unavoidably lost in changing or endeavoring to change the present locations for the benefit of those who are unwilling or unable to contribute anything from their own means towards aiding the work. This view of course pre-supposes, that the State will advance as rapidly to the company as to her own officers, by which course, the means of the State and of individuals will be simultaneously expended with a corresponding diminution in time. The security offered the State by the one-fourth part of what the southern counties would cheerfully contribute, would be a better guarantee against any misapplication of her funds than the united security given to the different State governments by all the "Internal improvement commissioners" in the Union.

That the cost of, and the time required to complete the southern railroad will be much greater as a State than as a private work, will be admitted by every disinterested man, and as already remarked, the interest on the additional sum due to government extravagance will aid in increasing the cost of transportation, and thus defeat the very object of the undertaking.

Some have perhaps been influenced in recommending this as a State work, by the expectation of seeing money spent with the same profusion in the southern, as in the central counties, and thus they advocate the southern railroad, as they would a lateral canal—that is, for the advantages derived from the expenditure of a large sum of money within a certain district. To such persons, any other arguments than dollars and cents, would be unintelligible, but the inhabitants of the southern counties generally desire the construction of the road for the purpose of developing the resources of that portion of the State, and they ask the government to undertake it, because the southern counties have been decidedly injured by the canal policy of the State of New York, and because they consider the project too great for private enterprise.

But how is the road to benefit the southern counties, unless by furnishing a *cheap* and rapid communication with the city, throughout the year? And what does the experience of this country offer, to show that railroads, as government works, afford as cheap a mode of transportation, as when in the hands of companies? The States of Pennsylvania and Michigan, have had railroads in operation for some time, the former owning the roads and locomotives, the latter owning every thing, and carrying on the forwarding business in all its details. The former plan was to avoid the im-

putation of monopoly, and it is the only *fact* advanced in proof of the ability of a State to manage a railroad with advantage. We will compare the cost of transportation on these State works, with that on some private roads. Strange as it may appear, the actual cost of transportation on the Philadelphia and Columbia railway was not known in Albany last winter, though a report of the superintendent was in the hands of the leading advocate and of the principal opponent of the southern railroad, Messrs. Dickinson and Wager. This document, like nearly all government reports on the subject of internal improvements, abounds in passages calculated to mislead. Thus Mr. Dickinson supposed that the cost of transportation was 12 mills per ton per mile, but his antagonist, Mr. Wager, saw a little further on, that the average rates of toll were $3\frac{3}{4}$ cents per ton per mile, or, as it is stated in the report, 15 cents per 100 lbs.—this mode of giving the charges preventing the generality of readers from perceiving the actual cost per ton per mile. In a note on the same page (Pa. Canal Commissioners Report, for 1837, p. 52) the superintendent gives a list of *prices of transportation* on different private roads—the lowest being the Baltimore and Washington railway, which is not allowed by law to charge more than 4 cents per ton per mile, or one-eleventh more than the *tolls* on the Philadelphia and Columbia railroad. The object aimed at was to lead to the belief that the cost of transportation on the latter road was less than on any private road. Now had this report been drawn up with the intention of giving correct information, it would have stated, that the sum paid by the community for the transportation of one ton of goods one mile was $9\frac{14}{100}$ cents. Another example of these miserable attempts at delusion is the following: (p. 52 ib.)

“It is not generally known that the tolls on the Columbia and Philadelphia railroad are lower than any other in the Union, but such is the fact.”

Those who have not given much attention to the extraordinary sense in which the commonest terms of the English language are used by no inconsiderable portion of the “officials” of the United States, will perhaps be surprised to hear that, at the time the above remark was written, Pennsylvania was the *only* State in the Union where railway *tolls* were known, and we believe continues so to this day. More yet, she was *then* the only State owning a railway in operation; all which was undoubtedly well known to the superintendent when he stated so positively, that the “tolls” on the Philadelphia and Columbia railroad were lower than on any other in the Union. (For an honest statement of the cost of transportation on that railway, see the clear and concise description of its construction and management by Mr. Wilson, one of the engineers.—*Railroad Journal* 2nd vol. 1839, p. 175.)

The supposed success of this railway was the only *fact* Mr. Dickinson could adduce in proof of the capacity of a State to manage a railroad with benefit to the public. Had Mr. W. known the *actual* cost of transportation on the Philadelphia and Columbia railway, Mr. D's grand argument, instead of being based on the success of that road as a State work, would have

been directed towards showing that its comparative failure to perform the duty of private roads to the public, did not apply to the southern railroad for a variety of those "reasons" which are never wanting in such cases.

The State of Michigan opened 30 miles of the "Central Railroad" in January, 1838, and carries on the forwarding business in all its branches, as well as the transportation of passengers, giving bills of lading for flour, butter, turkeys, live or dead hogs, etc., all under the direction of Commissioners appointed annually. There are of course no "tolls," the Philadelphia superintendent to the contrary notwithstanding—and the cost of transportation in 1838 was $37\frac{1}{2}$ cents per bbl. of flour carried 30 miles, or $12\frac{1}{2}$ cents per ton per mile, while the Mohawk and Hudson railroad, only 16 miles long, with three kinds and five changes of power, charged, and we believe still charges, $6\frac{1}{2}$ cents per bbl. of flour, or very nearly 4 cents per ton per mile, one third of the price charged by the State of Michigan. This same Mohawk and Hudson railroad charges for light goods 6 cents per ton per mile, which it carries throughout the year at the rate of 10 miles per hour for the very price charged on the Erie canal for transportation during seven or eight months, at the rate of two miles per hour. The rate for light goods from New York to Buffalo for 1839, was \$1 20 per 100 lbs. and, deducting 10 cents for the river, there remains \$1 10 for 363 miles, or 22 dollars per ton, or 6 cents per ton per mile. The hostility to railroads in a certain quarter, is not without reason, when "exclusive privileges" can alone keep the grass from intruding on the tow path.

The accommodations on State roads, are as contemptible as the price of freight is extravagant. In Philadelphia, the passengers embark and are landed, in the middle of Broad street, while in Detroit, they have not even a pavement to step on, but go direct from the car to the mud. The people of this State and of Massachusetts who have only travelled on the Albany, Troy, Utica, Boston and Lowell, Worcester, Salem, etc., railways, would be surprised at the truly sovereign indifference with which the sovereign States of Pennsylvania and Michigan regard the reasonable accommodation of the "—— multitude." On the Pennsylvania plan, cars and buildings must be furnished by individuals, and it is impossible that the public should, under that system, be accommodated as they now are on the Utica, Lowell and other private roads, for these arrangements require the investment of large sums of money, which can never be expected from those who have a mere temporary interest to serve.

The late Mr. N. Johnson was considered the ablest and most influential advocate of the southern railroad as a government work; hence his report may be expected to embody the views of its best friends. He alludes to the "success" of the Pennsylvania plan, but adds "should this plan prove to be deficient, we may safely rely on scientific and mechanical skill, and that spirit of invention and perseverance which characterizes the people of this State, to remedy its defects, and mature a more perfect system in the progress of experience." This is all very fine; but it will require some years

of experience in "this State," to put her on a par with Pennsylvania, and when nearly all our good locomotives are from Philadelphia and from one establishment, it is as well to avoid mentioning the scientific and mechanical skill which is yet to be shown. There can be little doubt that this skill will be shown, when the proper time comes, and that in a few years, establishments equal to those of Philadelphia will be found in New York, to which desirable result, nothing would contribute more than the construction of the southern railroad, by a company, which would, as a matter of interest, offer permanent inducements to the best mechanical skill in the country, which cannot possibly be procured by the ephemeral temptations of the political party, which may happen to be in the ascendant.

In another part of the above report, (No. 38 Sen. Doc. 1839, p. 9,) it is suggested that "such power and control over the commercial and productive interests of the country in the hands of a vast corporation" might prove injurious to "the purity of our institutions and the independent exercise of individual rights." The entire revenue of the federal government is under the control of comparatively few individuals in the large cities, yet they conduct the immense business of the exporting and importing trade of the Union and regulate the delicate and difficult matter of exchanges with foreign countries, with a degree of accuracy contrasting strangely with the abortive attempts of both the federal and State governments to equalize the currency, not only between distant parts of the Union, but between different parts of the same State. The Boston and Lowell railroad, which is supported by the trade and travel between these two places, carries more passengers and more tons of freight, per annum, than the great thoroughfare of the western trade of Philadelphia—the Columbia railway, yet the people of Boston have no more fear for the "purity of their institutions" than have the people of Birmingham for "their individual rights," because the greatest work of internal improvement in the world—the London and Birmingham railway, is owned and conducted by a private company, who have within four years, spent—not borrowed—30 millions of dollars, of their own money on a railroad, the like of which "has as yet been accomplished, in any country, by private or incorporated means,"—*only*.—(p. 9.)

The following admission, (p. 9,) yields all we ask for or even wish.—
"Where individual or corporate means are adequate to the accomplishment of a work, *even* with a reasonable proportion of aid from the State, it is doubtless sound policy to leave the work to such control, *exclusively*."

To this we cordially assent, and have no hesitation in declaring our belief that individuals in this State, will contribute towards the cost of the southern railway, in a greater proportion than do the citizens of Massachusetts, to the western railway. We again refer to the example of that Commonwealth. (Mass. H. of Rep., joint special committee, W. Lincoln, chairman, 27th Feb. 1839.)

"The committee were directed to consider the expediency of the purchase by the Com-

monwealth, of the western railroad. They were of opinion that it was not desirable, while the work remained unfinished, for the State to become the owner. Under the management of the agents of the corporation, it will be carried forward with more of expedition and economy, than by the public officers. If the right of acquiring the whole property at any time is reserved, it may be exercised when the heavy labors of construction are ended, and in return for the help proposed to be bestowed, it may yield large revenues for the use of the government.

When two-thirds of the amount of scrip, created by the act of February 21, 1838, shall have been expended in the construction of the road, then a further sum of \$400,000, in scrip, may be delivered to the corporation. When the private stockholders shall have paid, on their part, \$75,000, a further loan of \$400,000 may be made; and when \$75,000 more shall have been collected from the same stockholders, such additional sum may be advanced; as shall be ascertained by the Governor and council, to be necessary for the entire finishing of the road.

The right is secured to the Commonwealth, at any time, to purchase the franchise and property of the corporation, by reimbursing the stockholders, the sum actually paid by them, with interest at the rate of 10 per cent, annually.

Four of the nine directors are to be chosen annually, by the legislature."

How different is this policy, from that pursued by the State of New York towards the southern counties, which have, with great difficulty, obtained a loan of one tenth of the sum to be *given* to the central counties as fast as it can be obtained on the credit of the State, while to the southern counties it is peddled out in sums of \$100,000, after they have themselves contributed a like sum towards the construction of the work! Now if the same rule be applied to the enlargement and to the lateral canals, the southern counties would have less cause of complaint, but *their* immediate wants are passed by with indifference, while the most enormous expenditures are incurred in the central counties in anticipation of the present canal being at some future day unable to transport all the freight which *may* offer—the remote interests of the forwarders and the immediate interests of the contractors and speculators, on the line of the canal far outweighing all considerations of the honor, duty and interests of the State as concerned in the developement of the resources of other than the central counties. However glorious may be considered the day which saw the Erie and Champlain canals determined on, it will be eclipsed by that which shines on the rejection of all aid from the State to works, which are avoided by private enterprise, and in the construction of which, individuals will not risk *their own* means—the *only* never failing test of their sincerity, as well as the infallible measure of their confidence in the ultimate success of the undertaking.

It was well observed, some years since, by Judge Wright, that it required "less mind" to manage a canal than a railroad, hence the government is more competent to conduct the former than the latter. Every traveller when carried in a large train of passenger cars, with great velocity, feels his dependance on the skill and judgment of the engine-man; hence their pay is necessarily liberal, and it is worthy of remark, that even in England, there is some difficulty in procuring good men, though the wages are very nearly as high as in this country. Now were the southern railroad in the hands of the State, it is evident that these situations would be filled by political partizans, the lives of the passengers placed in jeopardy by their incompetence, the business delayed and the rates of toll as high as possible, to meet the heavy additional expenses, arising from the ignorance and in-

difference of the temporary occupants of stations which are held by a tenure, the very reverse of that, which would recommend the incumbents to a private company—the making the duties of their stations a secondary consideration.

It is useless to say, that this general proscription is unnecessary and must not be assumed "a priori;" we have 15 years experience in this State to the contrary, and are very much deceived if the year 1840 prove any exception to the rule. This principle, disgusting and degrading as it is, forms one of the prominent features of the times, is daily assumed to be absolutely necessary to any political party which expects to retain the ascendancy beyond its first period of appointment, and is justified in political matters by men, who would scorn a similar course in *their own* affairs. The difference between private and political morality is as strongly marked as that between truth and prevarication, between honor and hypocrisy. However much this state of things may be regretted, *it still exists*, and it is the province of men engaged in the active pursuits of life to view things as they are, not as they wish them to be or as they ought to be.

The patronage of the southern railroad as a State work would be immense—nearly as much as if she owned all the steamboats of the Hudson, all the packet ships of the City, or all the flour mills of the State. The number of votes which the railway could command would be as well known and as certain as the votes which the Erie canal has always given to the party in power, and which, we believe, it will continue to do; but, as a much higher grade of men is required on a railway than on a canal, the injury inflicted on the southern counties, by filling the most important stations with abject politicians, will be proportionally greater, as well as the general demoralization which so strikingly and disgustingly marks the canal policy of this State *since* the completion of the Erie canal.

Few suppose the State capable of undertaking and completing the southern railroad unless the enlargement be abandoned, which measure no politician would dare to advocate—hence the project of making the former a government work is nearly hopeless. The southern counties have however the power to *prevent* though not to *pass* any appropriations, and it will be by the exercise of this power, and by no other means, that they can obtain such aid from the State, as united with their own means, energy, enterprise and *economy*, will enable them to complete a railway from the Hudson to Lake Erie in 4 or 5 years, while if undertaken by the State, and carried on simultaneously with the enlargement, their completion may be expected about the same time—a period too remote to have any interest for the present generation. The true policy of the southern counties is, to secure a loan which, with their own contributions, will be *sufficient* to complete a single track, which we have stated might be done for 9 or 10 millions of dollars. And, deducting private subscription, the *loan* required would be about 6 millions or the probable amount which is to be *given* to a small portion of the inhabitants of the two counties traversed by

the Genessee Valley canal. The southern counties in common with the rest of the State must be eventually taxed for the lateral canals, and it is much better to pay their proportion by direct taxation than to pay the entire deficit in the form of tolls when the southern railroad shall form part of the "system" of State works. A very strong inducement to the canal counties to aid this work, would be to continue the present exclusive right of the Erie canal to carry freight, which it would then become as much the interest of the southern as of the canal counties to support. Fear and interest are the only motives which can have any decided influence in making the claims of the southern counties respected; a fair commentary on the moral effects of the system of State works in general.

There is one argument however in favor of the policy of making this a State work which we confess our inability to answer, though the *justice* of the measure may well be questioned. It was observed at Ithaca in July last, that the southern railroad would aid the State in enlarging the Erie canal. We have already alluded to the probability of this road as a State work, being under the necessity of supporting the "lateral canals," supposing the Erie canal to meet its own expenses. But, if it be required to hold up the former and to aid in enlarging the latter, we are unable to see the benefits it is to confer on the *southern* counties, however convenient it may be to the rest of the State.

The Superintendent of the Philadelphia and Columbia railway in his Report to the Canal Commissioners of Pennsylvania (Nov. 1838, p. 43.) says, "Unless some authority is recognized to prevent such as will not comply with the regulations, from continuing in a situation to violate them, it is believed that the State had better put an end to all connection with companies and take the whole business into the hands of its agents under the control of a responsible head. Under such an arrangement, operations on the road would be systematized, the public business done with far more economy, and travel and transportation be performed with greatly increased satisfaction to the public."

Here is an admission that the Pennsylvanian plan has not succeeded, and an earnest recommendation to the State to "put an end to all connection with companies" and enter fully into the forwarding business. This same officer, in another place, says that the experience of that road has fully proved that a railway can be well managed by a State! All the objections which we have urged against the management of railroads by Government are admitted to their fullest extent, and it is proposed to adopt the system of private companies, a measure which would be utterly repugnant to the people of this State, who have already commenced the work of curtailing, instead of extending the power of the Government, by abolishing the auction and bank monopolies, and who will not for a moment listen to any increase of the patronage or expenditures of the Government. To derive from a railroad all the benefits, which that species of communication is capable of conferring, requires a degree of regularity, subordina-

tion and discipline, little inferior to that of an army, and it is impossible to expect this from men whose very bread depends on the result of every general election. It would be more to the interest of the Southern Counties to build their railroad at their *own* cost and to manage it *well*, than to have the work *given* to them and managed in the style of the State railroads of Pennsylvania and Michigan. And why should the people of this State suppose that their Government is more capable of managing a railway than the Government of Pennsylvania where it is officially announced, that their present plan is deficient in system, economy and convenience? The mechanical skill of Pennsylvania is at least equal to that of New York and both are very far behind Massachusetts, yet the latter State declines entering on the construction of public works; and may we not fairly conclude that she does so *because* her superior intelligence and mechanical skill enable her to see clearly the impracticability of the scheme?

The speed also on the Philadelphia and Columbia railway does not exceed from 14 to 15 miles per hour, about two thirds of the average velocity on the Boston railroads of similar construction, and about equal to the ordinary rate of travelling on the Utica railway with the cheap or wooden superstructure. This is one of the inevitable results of endeavoring to conduct by mere electioneering agents, a business which requires all the attention, steadiness, skill and character of the ablest men whom individual sagacity can discover and by liberal inducements, *permanently* retain—their opinions on the subjects of religion, politics, metaphysics or the fine arts having no connection with the management of works conducted by individuals or companies.

All the railways of Massachusetts are constructed in the best manner with the heavy iron rail, while, in New York, we have only *one* edge rail—on the Long Island railroad. In the former State all is left to private enterprise, but here, the visionary projects of Government, called "State works," offer the security of the *whole* population for all the surplus capital to be had on either side of the Atlantic, and thus completely drain the sources on which private enterprise depends. Instead of allowing capital to seek a *judicious* investment, the State Governments come forward and offer the faith of the State for any sums which can be procured. The capitalist is thus saved the trouble of investigating the merits of the works for the construction of which he loans his money, and he feels just as sure of his interest on the money squandered on the Chenango canal, as on the money invested in the Erie canal. It is on this account, that our railways are so far behind those of Massachusetts, where the "faith of the State" has only been used to *aid*, not *extinguish* private enterprise.

Experience has shown that the railway cars, and engines must be under the control of a single head, if the full advantages of this mode of communication are to be reaped, and on this account they are denounced as "monopolies." They have the privilege, in common with the most trivial county roads, of going through any man's property, and for this they are

bound by law to carry passengers and freight at fixed rates, hence they have been justly styled the "poor man's friend." With the so called "free system" in use on Canals and Government railroads, the *tolls* only are fixed by law, the additional charge for that part of the business done by individuals being regulated by themselves. This anomalous partnership for the transportation of passengers and freight appears to unite the unavoidable disadvantages of State works, with the monopoly unjustly ascribed to private works, for we have seen that the superintendent of the Columbia railway inveighs strongly against it, and some remarks to the same point, founded on the experience of the Erie canal, may be found in the report of the late Comptroller, (Assem. Doc. No. 4, 1839. p. 25.)

Railway companies, being necessarily corporations, have come in for a share of the animosity felt towards banks, with which institutions they have nothing in common except the charter—the objects of the former being to enable an association of individuals to invest their money in forming cheap and rapid communications throughout the year between important points, not merely for the sake of dividends, but for the general advancement of the country traversed, by developing its resources and then rendering available its hitherto dormant wealth. This is effected by a combination of the latest improvements in science with the highest mechanical skill—requiring all the physical and mental energies—in short, bringing into play the highest attributes of man for the noblest purpose as well as the most prominent improvement of the day. We fully appreciate the exquisite skill and taste of the engravers and the occasional taste of the architects of the latter institutions, but, beyond this unimportant similarity we must decline acknowledging even a remote trace of further resemblance in their aims and effects, whether social, moral or political.

We will briefly recapitulate the principal reasons which have determined us to take ground against the adoption of this work by the State. The time required for its construction would be much, probably three times greater—the cost would be increased in the same ratio—the cost of transportation would be about double, owing to the great capital invested and to the reckless and extravagant manner in which State works are managed—reasonable comforts and accommodations are not to be thought of—the appointments will be, as they always have been, given to political hacks—when the enlargement has proceeded sufficiently far to absorb the entire surplus of the Erie Canal, the southern railroad must support the lateral canals, if the railroad be completed before the enlargement, of which we at least have little expectation, being firmly convinced that, if carried on simultaneously by the State, they will not be completed in 30 years—indeed we consider the adoption of the southern railway by the State to be the most efficient course its enemies could pursue effectually to defeat the project.

We are compelled to omit a part of the memorial of the New York and Harlem Railroad Company until our next, when we shall give it accompanied by remarks and interesting railroad statistics.

MEMORIAL OF THE NEW YORK AND HARLEM RAILROAD COMPANY.

To the Honorable the Mayor, Aldermen, and Commonalty of the City of New York, in Common Council convened,

Respectfully Sheweth—

That your memorialists, in soliciting enactments in their behalf, deem it proper, in order to guard against misconceptions, to address to your honor-

able body a memorial, setting forth the views by which they are actuated. And in the performance of this duty, the directors deem it unnecessary to advert particularly to the causes which have retarded the full developement of their purposes, and the entire success of their company. They were such as are generally incident to undertakings of equal difficulty and magnitude. Their effects have principally fallen upon the enterprising individuals who projected and aided the construction of the work, and upon the stockholders who furnished the means.

The task, however, is now nearly accomplished. The plan which has cost so much toil and sacrifice, is carried through to the completion of a double track of railway from the City Hall at the Park, to Harlem River; and the causes heretofore operative in creating opposition and multiplying difficulties, have ceased, or soon will cease to exert any material influence.

This great work, therefore, cannot be dispassionately viewed in all its aspects, and its value remain unacknowledged.

Your memorialists deem it unnecessary to present arguments to prove the superiority of railroads over former modes of travelling, as they believe it already conceded, not only in the United States, where upwards of four thousand miles of railroads are now in successful operation, at a cost of eighty millions of dollars, but throughout Europe, where they are esteemed the most desirable mode of travelling, so far as comfort, expedition and economy are concerned.

Your memorialists, therefore, deem it only necessary to examine whether there is any cause to believe that the city of New York is, in its relations with this company, an exception to the system that now meets universal sanction and support, both at home and abroad, and especially in our sister cities of Boston, Philadelphia and Baltimore; where, it must be known to your honorable body, that railroads have been laid through and across some of their most busy and crowded thoroughfares, to the water's edge.

The Board have taken great pains to ascertain the feelings and opinions of the people generally of those cities, and especially those who own or occupy real estate along the streets through which the rails are there laid; and so far from finding dissatisfaction, they learn, on the contrary, that branches are solicited in streets other than those already supplied; the people's preference of rails to stages and omnibuses being thus unequivocally manifested.

Will New York, the commercial emporium of this great continent, become the first and only city to exhibit opposition to the continuance and extension of railroads within her limits?—an improvement, too, which ranks among the greatest of modern times, and which is destined to produce as great a revolution in the conveyance of passengers on the land, as steamboats have done on the water?

Your memorialists, with their knowledge of the reception of railroads in other cities, would respectfully inquire, what are the objections to the extension of the rails of the company, to such points in this city, on the North and East rivers, as the public and your honorable body may deem necessary for transporting the inhabitants from one extreme part to the other, with despatch, comfort, safety and economy? Especially, as it is generally admitted, that time is money, and that the attainment of greater speed and certainty, amounts in effect to a reduction of expense.

It will not, at this day, be denied, that the advantages of a speedy conveyance are often of greater value than the whole charges of transportation.

But your memorialists cannot conceal from themselves, nor hesitate to declare to your honorable body, that so far as they have been able to ascertain the character of the opposition to the extension of their rails, they be-

lieve the greatest objection to be, that which has become common, and we may add, popular—the denouncement of all incorporations, as “odious monopolies,” however important to public accommodation.

It therefore becomes the duty of the Board of Directors, to examine the validity of this objection, and in doing so, they beg respectfully to represent to your honorable body, that they conceive there is cause to believe, that railroads, in large and populous cities, form an exception to the general rule, even admitting incorporations, to be “odious monopolies.”

In proof of this position, your memorialists feel it necessary merely to refer your honorable body to the mode of constructing railroads—to the space they require—to their rapidity of conveyance—to the impossibility of turning out to the right hand or to the left—and to the necessity of uniform speed; clearly to indicate the impracticability of their indiscriminate use by our citizens, in the manner of the canal, the turnpike, and other highways.

If the Board are correct in this view of the subject, the conclusion seems irresistible, that the proprietors of a railroad must be the sole and exclusive carriers and regulators of the vehicles to be used thereon.

It follows, that if the city of New York is to enjoy the superior benefits of railroads, it can only have them, subject to these conditions.

Further, it should not be forgotten, that the rail cars occupy no more space on the public street, than would be occupied by any other vehicles used to perform similar duty; neither should we disregard the important fact, that this company are now conveying more than *one million two hundred thousand passengers per annum*, on a railroad constructed by them, and kept in order at their expense; by which, it is obvious, that a great saving accrues to the city treasury, the same number of passengers conveyed in stages and omnibuses, subjecting the city to an increased expenditure, to keep in repair the pavements over which they would travel.

Your memorialists would further represent, that in viewing the work which this company has constructed, and looking at its present condition and probable future usefulness it appears to them but reasonable to inquire, who has been the gainer?

Is it the Stockholder? Is it the Farmer? Is it the Landholder? or is it the inhabitant residing contiguous to the route of the road?

In reply to these questions, it is with deep regret that your memorialists find themselves under the necessity of stating, that up to the present moment the stockholders have never received one dollar of revenue from the company, although they have long since contributed upwards of eight hundred thousand dollars in cash, toward the construction and completion of their present work.

The expenditures on this road, together with the preparations for using it, have amounted to about one million one hundred thousand dollars; and the company have been compelled to borrow the amount which was required beyond that paid by the stockholders—leaving them now in debt to the amount of two hundred and fifty thousand dollars. The receipts for fare, by the company, will amount, in the present year, ending on the 31st of December, 1839, to about one hundred thousand dollars; being sufficient to defray every expenditure, together with the annual interest upon the debt of two hundred and fifty thousand dollars.

From this statement it is evident that there is no immediate prospect of a dividend for the benefit of the stockholders; and having thus far persevered in good faith to complete their great and useful work, and also having conveyed upon the road, from its commencement in 1832, to the present day, *three millions eight hundred and ten thousand passengers*, by the safest mode and at the cheapest rate, they consider themselves deserving the favorable notice of the city councils.

[To be continued]

For the American Railroad Journal and Mechanics' Magazine.

BROOKLYN, DECEMBER, 13TH, 1839.

GENTLEMEN:

The interest that has long been manifested on the part of the residents on the northerly side of the Island for the continuation of the Long Island Railroad on the east of Hicksville in this direction, has induced those gentlemen to have recently a survey of this route made by permission of the company, in consideration of the amount of aid proposed to be given by the residents on the northern route in the event of its continuation on this side of the Island, and my report and estimates on the cost of this route accompany this communication which are at your service for publication.

Very respectfully, your obedient servant,

EDWARD SHOTWELL.

REPORT ON THE EXTENSION OF THE PRELIMINARY SURVEYS OF THE LONG ISLAND RAILROAD ON THE NORTHERN ROUTE.—TO MESSRS. JONES, BOLTON, SMITH, GARDINER, MILLS, &C., COMMITTEE ON BEHALF OF THE RESIDENTS ON THE NORTHERN ROUTE.

GENTLEMEN:

I have the honor to state that the examinations and survey of this route, have been completed to the extent anticipated by your instructions, and that an approximate estimate of the probable cost of graduation and masonry, for a single track railway has been based upon the results of these examinations. As the accompanying drawings and papers will exhibit the details, I offer the following report as embodying my views on the feasibility of the route.

In conformity with your instructions, the survey of the northern route, has been made from Hicksville, the present terminus of the Long Island railroad, through Woodbury, Huntington, and Smithtown, terminating in the vicinity of the latter place, where it forms a junction with the present located southern route.

A due examination of the topographical features of this route was made, prior to the commencement of the surveys, the results of which led me to a conclusion on the necessity of approaching the following points, in the projection of the survey of the east of Hicksville, as constituting the only feasible route existing on the northerly side of the Island, without too near an approach to the main shore, and having in view a connection with the present south route, in the vicinity of Smithtown. Cross the turnpike near Mr. Hewlett's tavern, and after reaching Carle's point, continued to Ketcham's Hill and effect a crossing of the Smithtown branch on the north of Messrs. Blydenbergh's Mills.

In accordance with this opinion the surveys that have been prosecuted, embrace for the most part one line with its modifications.

Commencing at Hicksville, a prolongation of the present located line was made, of 500 feet on the east of the depot, where a curve of an easy radius was introduced, to gain a course for the entrance of a valley, about half a mile on the south of Woodbury, and four miles distant from the point of departure, where another curve of considerable radius but of short length was made. The direction then given the line was Carle's Point, which passed the summit of this valley as favorably as a tangent would allow of, and crossed the Jericho and Smithtown turnpike about 1000 feet on the west of Carle's Point.

After reaching Carle's Point on this line a distance of six and a half miles

from Hicksville, a curve of a suitable radius was again made and prolonged into the course of Ketcham's Hill, a distance of four and a half miles from the latter place, when an offset of 200 feet south, was made in order to attain the lowest depression of these hills.

On reaching this point, the line was continued in the direction of the Smithtown branch, and crossed the turnpike one mile on the east of Commack, but on gaining the vicinity of the branch, an offset of 2200 feet on the north was found necessary in obtaining a crossing of the branch at the most favorable point for this line, the continuation of which would have passed on the south of the mills, and consequently come in contact with the mill pond and its branches.

The offset here made, terminated on the west of the branch, and after reaching the opposite side, a curve was made until I could gain for the continuation of the line, an east course, with a view of avoiding the mill pond and its auxiliary branches.

The prolongation of the course, here acquired by the curve on the east of the branch did not, however, wholly avoid the branches which flow into the mill pond. A circular bend of the swamp, a mile distant from the branch, flanks this line on the north, which is quite objectionable, because of the necessity of twice crossing the same swamp, and the line traversing a dividing ridge between some elevation above the general surface, on either side, an offset of 600 feet north on crossing this swamp was made, which, when connected, would entirely avoid it.

The same course was then preserved, crossing in advance another swamp of similar character but of less magnitude, until it reached the Smithtown and Islip road, due south of the Smithtown church in the vicinity of Esq. Hubbs's, a distance of over two miles from the branch.

After which I gave the line a direct bearing, to gain an intersection with the southern route, in the vicinity of Mr. Carman Ferry's, crossing immediately Beaver dam.

The distance from Hicksville on this line, is 20.70 miles, traversing a section of country varied in its topography, and encountering obstructions in the vicinity of West Hills, that render a portion of the line wholly impracticable, requiring a resort to gradients of 60 feet per mile, and the cost of graduation exceeding the limit of a reasonable expense. But the remaining portions of the line could be made subject to the limit of 40 feet, about seven miles of which, would require the maximum.

The second line has its commencement at Hicksville, and has been surveyed with an intention to avoid, as far as possible, the obstructions presented by the former line, to do so, it has been found necessary to adopt more curvature in the vicinity of Woodbury.

From Hicksville, the projection of this line has been made in the direction of the residence of Esq. Jones, for a distance of four miles, where a reverse curve, with an intervening tangent of 400 feet occurs, crossing the Cold Spring road twice, and turnpike directly in front of Mr. Hewlett's tavern, and continuing on the north of the turnpike, to a point one third of a mile on the east of the toll gate, where the line twice crosses a bend of the road, and intersects with the base line in its approach to Carle's Point, having intermediately two curves, one of which may be avoided in a location without an increase of expense.

From Carle's Point, the line pursues the course to Ketcham's Hill, and after reaching it, deflects to the south, but pursues a more easterly course than the former one, and crosses the turnpike at Gravelly Hill, and the branch on the north of Messrs. Blydenbergh's Mills, and at the same point with the base line, on a tangent of six and a half miles from Ketcham's

Hill, and after heading the branches of the Mill pond, the line deflects to the south of east, and crosses the base line near Esquire Hubb's, and continues to pursue a straight course with the exception of a slight offset to the southern route, crossing a bend of the swamp abreast of Smithtown, and the mouth of a valley near Mr. Hommediens, and ascending the ridge flanking this valley on the south, to Brush Plains, which the line traverses to the point of intersection on the 15th section of the 3d division of that route, being a distance of four and a half miles in advance of the branch.

The distance on this line from Hicksville is 21.91 miles, and on the southern route, 21.45 miles, making a difference of 0.46 miles against this route.

The increase of distance to the termination of the first division, properly chargeable to this second line, is 800 feet over the former one, and the difference of the two lines to their points of intersection with the south route, is equal to 1.21 miles.

The surface of the plains of Oyster Bay, traversed by this line on the east of Hicksville, favors very much the construction of the road, the undulations of which, are but trifling—the approaching grade, however, to Woodbury, amounts to 30.09 feet per mile, but becomes less for a short distance in advance, when it descends quite rapidly in the direction of Carle's point, the line traversing a number of spurs in the progress of its descent to the valley, which is more undulating than the plains, in its rear it does not, however, present any obstructions to the adoption of easy grades, until the vicinity of Ketcham's hill is encountered, the passage of which, requires the maximum rate of 40 feet, as in the descent from West Hills to Carle's Point, a plane of a mile in length on either side, is here necessary to overcome this elevation which, is the greatest attained on the whole line, being 265.43 feet above tide at Brooklyn, and 119.43 above Hicksville, a distance of 11.10 miles through the vicinity of Woodbury, will constitute the summit when graded.

The surface of the ground in advance of this former point is favorable to the adjustment of easy grades, having a descent towards the Branch in the direction of which it soon becomes depressed from the level of Hicksville, without again attaining the same elevation. The two last miles in approaching the branch require the application of the minimum rates of inclination, and is the most formidable section on the whole line, descending rapidly in the vicinity of the branch which is but a few feet above tide, and has an average width of 900 feet at this point, and apparently affords no better point of crossing, having the same descent in the same distance, and requiring an increased length of embankment.

The average cutting necessary in the descent, is about 22 feet, for a mile, and the average embankment, about 37 feet. In the ascent from the branch a grade line of 23.76 feet per mile, is all that is required, and falls below this for some distance in advance, until the ascent to Brush plains require 39.91 feet per mile, for over a mile and a half, this, however, is susceptible of much improvement in a location, by pursuing the course of a branch ravine which favors the direction of the line, a few hundred feet on the north, and the cutting may be somewhat diminished in the descent to the branch on a final location.

Exclusive of the curvature necessary at the points of diverging, there is required about 8000 feet of curved line, varying in radius from 2000 to 4000 feet, and divided into seven curves, about seven-eighths of which quantity is located on the first division, extending to Ketcham's hill, and principally in the vicinity of West hills, and on the former line there is about

3500 feet of curved line of similar radius, and about an equal quantity on each division.

In the crossing of the branch near Smithtown, there will be required a bridge of not less than 200 feet span, and the foot of the embankment to be protected by a retaining wall, it may, however, be passed on wood work, and the cost somewhat diminished by this mode, if hereafter considered necessary, and the estimate for masonry has anticipated the cost of procuring rock of a suitable quality from the opposite shore. That required in culverts and drains, can be procured on the Island, suitable for rubble work.

The embankments on the first division will have a predominance, and on the second division, the excavation considerably.

The quantity of curved line that has been introduced on the first division in the vicinity of West Hills is only what is required by the occupancy of the same ground. But in my opinion a reduction of that quantity can be made much in favor of the character of the road, and without a material cost beyond the present route by diverging from Hicksville on a tangent, and crossing the turnpike on a curve, and continued in the rear of Mr. Hewlett's tavern, and intersect line No. two of this survey, at the bend of the turnpike on the east of the toll gate, and from thence become common to line No. two with but a slight deviation the entire route, or else attempt to gain Carle's point on a tangent, by the curve proposed at the first crossing of the turnpike. To encounter the ridge anticipated by the latter line, would be attended with a considerable expense, yet might be considered practicable in view of the continuation of the main line on this route, with these exceptions, subject to future survey. I have no hesitation in recommending the route as practicable within the limit of 40 feet for grades, and that the estimate will cover the cost of road formation.

The estimate for fencing, anticipates that portion which cannot be dispensed with, but if continued the entire route, it will be subject to an increase, and the estimate of graduation embraces a road way proper of fourteen feet in excavations, and fifteen feet in embankments, being the minimum width for a single track railway.

Annexed is a table of grades adopted on this route, the maximum rate being fixed at 40 feet per mile, and they will not suffer in comparison with a number of our railroads.

In conclusion, I but perform a pleasing duty in tendering, through you, my acknowledgements for the attentions and assistance of the gentlemen composing your committee.

All of which is respectfully submitted.

EDWARD SHOTWELL, *Civil Engineer.*

Huntington, December 10th, 1839.

NORTHERN ROUTE.

Estimate of cost of graduation. First division extends to Ketcham's Hill. 11-10. miles.

Clearing and grubbing,	1,580 00
Graduation,	47,200 00
Masonry,	7,160 00
Fencing,	6,425 00
	<u>\$62,365 00</u>

Second division extends to southern route, 10-81 miles.

Clearing and grubbing,	2,160 00
Graduation,	64,425 00
Masonry in bridge and culvert,	15,195 00

Superstructure,	2,200 00
Fencing,	5,600 00
	\$89,580 00

RECAPITULATION.

First division,	62,365 00
Second division,	89,580 00
	151,945 00
Add for turnouts 10 per cent.,	15,194 50
	167,139 50
Add for engineering and superintendence, 10 per ct.,	16,713 95
Total cost,	\$183,853 45
Equal to \$8,391 30 per mile.	

Table of Gradients of the Northern Route.

No. of plane.	Length of each. Feet.	Direction.	Inclination per mile.	Elevation or Depression.	Total elevation above tide at Brooklyn. Feet.	LOCALITIES.
			Feet.	Feet.	Feet.	
1	10000	ascent	13.20	25 00	171 00	Oyster Bay Plains.
2	5000	ascent	16.15	15.30	186.30	Ditto.
3	7400	ascent	30.09	42.18	228.48	
4	400	level	00.00	00.00	228.48	Cold Spring road.
5	4185	ascent	26.40	20.92	249.40	Turnpike.
6	12115	descent	39.91	91.58	157.821	Carle's Point.
7	1900	level	00.00	00.00	157.821	
8	4170	ascent	26.13	20.64	178.46	
9	5230	ascent	13.20	13.07	191.53	
10	2920	ascent	3.69	2.04	193.57	
11	5280	ascent	39.86	39.86	233.43	Ketcham's Hill.
12	5400	descent	39.91	40.82	192.61	Ditto.
13	4000	descent	20.06	17.68	175.13	
14	3900	descent	39.60	29.25	145.88	
15	5700	level	00.00	00.00	145.88	Commack.
16	2700	descent	17.42	8.91	136.97	
17	11100	descent	39.91	83.91	53.06	
18	600	level	00.00	00.00	53.06	Smithtown Branch.
19	1800	ascent	23.76	8.10	61.16	
20	4200	descent	21.12	16.80	44.36	
21	4000	ascent	13.20	10.00	54.36	Swamp.
22	2000	level	00.00	00.00	54.36	
23	9000	ascent	39.91	68.04	122.40	
24	2100	descent	31.68	12.60	109.80	Brush Plains.

Recapitulation of Grades.

2.007 miles, level.	
0.550	level to 10 feet per mile.
5.100	10 to 20 " "
2.000	20 to 25 " "
1.582	25 to 30 " "
1.800	30 to 35 " "
8.862	35 to 40 " "

DESCRIPTION OF THE GALVANIC TELEGRAPH AT THE GREAT WESTERN RAILWAY.—The space occupied by the case containing the machinery, (which simply stands upon a table, and can be removed at pleasure to any part of the room,) is little more than that required for a gentleman's hat box. The telegraph is worked by merely pressing small brass keys (similar to those on a keyed bugle,) which acting by means of galvanic power, upon various hands placed upon a dial plate at the other end of the telegraphic line, as far as now opened, point not only to each letter of the alphabet, as each key may be struck or pressed, but the numerals are indicated by the same means, as well as the various points, from a comma to a colon, with notes of admiration and interjection. There is likewise a cross (X) upon the dial, which indicates that when this key is struck, a mistake has been made in some part of the sentence telegraphed, and that an "erasure" is intended. A question—such, for instance, as the following—"How many passengers started from Drayton by the 10 o'clock train?" and the answer, would be transmitted from the terminus to Drayton and back in less than two minutes. This was proved on Saturday. This mode of communication is only completed as far as the West Drayton station, which is about $13\frac{1}{2}$ miles from Paddington. There are wires (as may be imagined) communicating with each end, thus far completed, passing through a hollow iron tube, not more than an inch and a half in diameter, which is fixed about six inches above the ground, running parallel with the railway, and about two or three feet distant from it. It is the intention of the Great Western Railway Company to carry the tube along the line as fast as completion of the rails takes place, and ultimately throughout the whole distance to Bristol. The machinery and the mode of working it, are so exceedingly simple that a child who could read would, after an hour or two's instruction, be enabled efficiently to transmit and receive information.—*Observer.*

Manchester and Birmingham Railway.—Congleton Viaduct.—The first stone of the celebrated viaduct at Congleton, on the line of the Manchester and Birmingham railway, was laid with much ceremony on Wednesday the 26th September. Those of our readers who are interested in railway undertakings, know the magnitude of this work; but by those who do not, the following particulars will be read with interest. The viaduct is intended to run in a direction nearly north and south, and will cross the river Dane at a point about three chains below the extensive silk mill of Mr. Samuel Pearson. It will cross the Newcastle road at a point about a chain to the west of the corner of Dane street. In length, the viaduct will be 3078 feet, or nearly a mile, 31 feet in width, and twenty-seven feet between the parapets; the span will be 60 feet with 20 feet rise. There will be 42 arches, which are segments of circles. The greatest height from the river to the rails will be 98 feet 6 inches. The bases of the piers are intended to be of stone for about twelve feet in height above the ground; the imposts and parapets will also be of stone, and the rest of the structure of brick. The viaduct will contain about 61,000 cubic yards of brick work, and about 586,000 cubic feet of stone work, and is expected to be completed in two years and a half. The contractors are Messrs. John and Samuel Blakely of Manchester. The engineers in chief of the railway are Robert Stephenson and George Watson Buck, Esqrs., and W. Baker, Esq., a young gentleman of promising abilities, is the assistant engineer of the Congleton length—M. Buck stated that the viaduct would be the most gigantic structure ever attempted in this country—in this kingdom—or indeed in Europe, in modern times. It would be a thousand feet larger than

the largest bridge of masonry in Europe, which was the *Pont du Saint Esprit*, over the Rhone. It would be more than three times the height of that bridge, and it would occupy six times its volume.—*C. E. & A. Journal*.

New Locomotive Engine.—Messrs. Peel, Williams and Peel, of the Soho Iron Works, Ancoats, have recently turned their attention to the manufacture of locomotive engines for railroads; and on Wednesday trial was made of their first engine, on the Liverpool and Manchester line. The general form and disposition of the parts of this engine resemble those of the Liverpool and Manchester and Grand Junction lines; the only difference being in the mode of working the valves. There are no eccentrics, but in place of them, two spur wheels staked on to the crank axle, driving two other wheels of equal diameter placed immediately over them, and running in a frame supported by a crank axle, so as to preserve the distance between the centres constantly the same, and unaffected by the motion of the engine on its springs. The wheels last mentioned are attached to a short axle or shaft, carrying at each end a small crank arm, which drives a connecting rod attached to the valve spindle. There is likewise a very important and creditable improvement in the construction of the striking lever for reversing the motion, which we are unable to describe intelligibly without the aid of a drawing. The results of the experiments on Wednesday, during a trip from Manchester to Liverpool, with the nine A. M. first-class train consisting of seven carriages each weighing five tons as reported by Mr. Edward Woods, the superintendent engineer, were most satisfactory. On the same day, the engine performed another experimental trip, from Liverpool to Manchester, with 25 loaded waggons, weighing in the gross, 133 tons 18 cwt. 2 qrs. Previous to this experiment, the "Soho" had been running a fortnight with passengers on the Liverpool, and Manchester line, and during that time Mr. Woods informs us "no failure has taken place, and the trains have usually been brought in *before their time*."—*Manchester Courier*.

Alloy of Metals.—A curious and valuable discovery has just been made in the alloy of metals. A manufacturer of Paris has invented a composition much less oxidable than silver, and which will not melt at less than a heat treble that which silver will bear; the cost of it is less than 4d. an ounce. Another improvement is in steel; an Englishman at Brussels has discovered a mode of casting iron, so that it flows from the furnace pure steel, better than the best cast steel in England, and almost equal to that which has undergone the process of beating. The cost of this steel is only a farthing per pound greater than that of cast iron.

Simple Remedy to Purify Water—It is not generally known as it ought to be, that pounded alum possesses the property of purifying water. A large table spoonfull of pulverized alum, sprinkled into a hogshhead of water, (the water stirred round at the time,) will, after the lapse of a few hours, by precipitating to the bottom the impure particles, so purify it that it will be found to possess nearly all the freshness and clearness of the finest spring water. A pailfull containing four gallons, may be purified by a single tea spoonfull.—*Doncaster Chronicle*.

The receipts on the Charleston and Hamburg railroad, for the month of November, amount to \$65,000, being nearly 50 per cent. more than was ever before taken in any one month. During the period alluded to 15,000 bales of cotton were brought to market, which is double the quantity received in any previous month, and it is stated that the business of the road is now carried on with less machinery than was before used.

CENTRAL (GA.) RAILROAD.—We present our readers with the 4th semi-annual report of the Chief Engineer—L. O. Reynolds, Esq.,— of the Central railroad in Georgia; which shows that that work, at least, is progressing to an early completion.

From this report it appears that the same spirit of extortion prevails in Georgia, among the proprietors of land, as in many routes in other sections of the Union.

It is surprising, yet true, that many persons owning property on contemplated lines of improvements, are exceedingly desirous to have the work pass their doors, *until* it is permanently located, when they discover as if by magic, that it is a great nuisance.

We would call the attention of the readers of the Journal to an article on this subject in No. 7 of this volume, by W. R. Casey, Esq., Civil Engineer, which gives a graphic description of this system of extortion. Mr. Casey lays it down as a *practice*, at least, if not a principle, that damage is usually increased in proportion to the benefit to be derived by the individual, from the operations of the company—whereas, the reverse should be the case.

ENGINEER DEPARTMENT, CENTRAL RAILROAD, }
Savannah, November 1st, 1839. }

To W. W. Gordon, Esq., President:

SIR—The period has again arrived when it becomes my duty to present you with a report of the operations of this department, and the condition and progress of the work under its management

At the date of my last report, the grading was under contract to a point 133 miles from this city, and 114 miles of it finished. The contracts have since been extended to 136 miles, of which 128 are graded. The line has been definitely located and prepared for contract to the Oconee river, a distance of 148½ miles.

The portion of the grading from the summit near Sandersville to the Oconee river, has always been regarded by many of our stockholders, as a most difficult and expensive part of the road. I take pleasure in assuring them that the cost of the excavation and embankment of the most expensive mile in that distance, will very little exceed \$12,000, and the average of the 14 miles now ready for contract will not much exceed \$5000.

The superstructure is completed for a distance of 93 miles, and we hope to be able to run our engines to the 100 mile station early in the month of January.

By the condition of our late contracts for grading, the contractor is to receive in payment 75 per cent in the stock of the company at par value and the remaining 25 per cent in cash—prices at the estimate of the engineer. Several applications for further contracts on these conditions have been received, and I am under the impression we shall be able to let as much of the work as is desirable the present season, at these rates.

Most of the work during the past summer, has been in the low grounds of Williamson's Swamp, and although the extreme dry weather has been very favorable for its execution, it has had the effect of rendering some portion of the line unhealthy. The work has consequently been somewhat retarded by sickness among the men. We shall, however soon reach a more elevated and healthy country, and I do not apprehend any difficulty hereafter on this account.

The force at present on the line—consisting principally of blacks, with a large number of carts and horses, is equivalent to about 500 men.

The views expressed in my last report on the subject of the employment of slave labor, have been much strengthened by the experience of the last summer, for had the force employed consisted of whites instead of blacks, the sickness and mortality would doubtless have been great.

The few white laborers employed have suffered much in proportion to their numbers.

We have within the last six months experienced some difficulty, on the subject of the right of way; but it is to be hoped that time, in more fully developing the benefits of our enterprise, will dissipate the prejudices and convince the judgment of such persons as are honestly doubtful of its advantages, and for a remedy against those who are actuated alone by mercenary motives in their opposition, it is presumed that an appeal to the public through the proper tribunals, and in obedience to the laws of the land, asking for strict and impartial justice, will result in a righteous decision.

While on the subject of the right of way, it may be remarked, that in every case where a sale of real estate has taken place near the line, since the commencement of the work, the price has been much advanced, and in some cases to many times the amount that would have been demanded before the road was projected. In some instances the amount paid to the proprietor of the land for pine timber for the construction of the road, has exceeded the price that the entire tract would have sold for three years ago.

In the absence of more extensive experience as to the effect of the road on the value of lands in its vicinity, that of others similarly situated may with propriety be invoked to aid us in our conclusions.

The President of the South Carolina railroad company in his semi-annual report of July 10th, 1837, page 10, says—"To give some idea of the advantages derived by those not immediately connected with the company, by the passage of the road through so great an extent of pine barren, a moderate estimate has been made of the additional value of these lands since the road was located, and it has been found that the advance within a mile of the road, and beyond the influence of the towns at each end, not including any thing within fifteen miles of either extremity, has been equal to the cost of the original construction of the whole road."

"The constant supply of timber for repairs, and wood for consumption, gives employment to hundreds on the line—these, and those with their families engaged about the road, would increase the number to *thousands* who have their support from this institution."

In the location and construction of the road, the most positive injunctions have been given to all persons entrusted with the management of the operations, so to conduct them as to do the least possible injury to the interests or property of persons along the line.

It may be further remarked, that in the commencement of the company's operations, when it was determined to pursue the "southern route" through the counties of Bryan, Tattnall, Laurens, &c., the almost universal complaint in the section of country through which the road now runs, was, that their interests had been entirely neglected, and the best route rejected—and *vice versa* since the southern route has been abandoned, the same dissatisfaction has prevailed throughout that region. It was therefore a fair inference that the change would be at least, acceptable to the portion of country that is traversed by the road. To what extent our apparently just expectations are to be realized or disappointed, is not yet fully developed.

I have recently made an examination of the superstructure throughout the line, and am happy to be able to report that it is in excellent condition.

The advantages of a continuous bearing, by means of our broad string-piece laid flatwise are daily more apparent. In colder climates, where it is necessary, and even unavoidable that the foundation should be laid so low as to be out of the reach of frost, such a bearing might not be admissible;—but in our climate we have nothing to guard against on this score; it is therefore, evident that the nearer we lay our foundation to the surface of the grade, the more accessible it is for the purpose of repair, renewal or adjustment.

The objection commonly urged against our peculiar plan of superstructure, arises from an apprehension, that the ribbon which immediately supports the plate rail, will give way and be crushed by the weight of the engine. We have been running burthen and passenger trains over the road daily for more than eighteen months and for some time past, from two to three trains per day, and with the exception of the renewal of the ribbon for a few miles on the lower end of the road for the purpose of substituting a different kind of connecting plate, I am confident there has not been one tenth of a mile renewed for the whole distance of 80 miles. I have during the past summer travelled over a great number of railroads, and have paid particular attention to the subject of the cost of maintaining track, I have seen no one on which the plate rail is used that can be kept in repair at a smaller cost than ours. The sides of the embankments are becoming covered with vegetation, and will in a year or two be entirely protected from the effect of rains.

The alignment of the road for the distance located, comprises 61 curved, and 62 straight lines.

The curves are all arcs of circles and may be classed as follows:—

Lenth of Radius.	Number of Curves.	Aggregate distance.
2,000 feet.	14	24,359 feet.
2,500 "	3	6,608 "
3,000 "	2	4,086 "
3,500 "	3	7,435 "
4,000 "	7	15,369 "
4,500 "	2	4,980 "
5,000 "	12	40,472 "
8,000 "	4	12,984 "
10,000 "	6	23,405 "
15,000 "	5	21,916 "
20,000 "	1	8,374 "
30,000 "	1	4,620 "
150,000 "	1	26,500 "
Total	61	201,109 feet.
Total length of curved line,		38 miles and 469 feet.
" " straight line,		110 " " 2,591 "

Distance located 148 miles 3,060

The last mentioned curve of 150,000 feet radius, and about five miles in length is, so far as any effect of resistance is considered, fully equivalent to a straight line, at any velocity. We may therefore with propriety state the proportion of straight line at two thirds the whole distance.

The gradients may be classed as follows:

Level,	miles.	feet.
Inclinations of 5 feet per mile and under,	20	2200
	43	1560

over 5 and under 10	22	3440
over 10 and under 15	14	5180
over 15 and under 20	12	940
over 20 and under 25	8	2360
over 25 and under 30	26	3020
Total	145	2860

The arrangement of the curves and slope grades, is such as to avoid, excepting in a few instances, the occurrence of a sharp curve on a heavy grade.

Water stations are established ten miles apart, or as near this distance as the circumstances will permit. At each station is a "turn out" about 800 feet in length, to allow two trains to pass each other. It is presumed that it will at a future day become necessary to place "turn outs" intermediately between the present ones.

In most instances store-houses will also be erected at the stations for the accommodation of the local business—and dwellings for the persons entrusted with the supervision of the road.

The amount expended on account of the road to this date is one million one hundred and eighty-seven thousand seventy-two 55-100 dollars.

The respective items of expenditure are as follows:

For grading, including bridges and culverts,	\$518,463 11
" Superstructure,	137,293 61
" Iron rails, spikes plates,	167,711 22
" Right of way, houses and lots,	13,844 50
" Carpentry,	22,480 97
" Smithry,	13,323 63
" Negroes,	922 25
" Locomotive engines	40,016 05
" Lumber,	27,924 32
" Iron for smithry,	17,969 02
" Teams and forage,	18,910 48
" Drayage, freight, &c.,	2,974 85
" Repairs of road,	5,836 03
" Implements,	25,886 16
" Railroad cars,	24,886 70
" Depot at Spring Hill,	11,030 29
" Brickyard,	2,060 25
" Engineering,	92,969 31
" Transportation expenses,	10,964 41
" Miscellaneous expenses,	39,605 39

Total,	\$1,197,072 55
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From this amount may be deducted for implements, &c., on hand,	10,000 00
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Nett expenditure,	\$1,187,032 55
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Our examinations since the date of my last report, have not developed any features in the character of the country, leading me to doubt the sufficiency of the sum estimated at that time for the entire completion of the road, and if the company were at this time in possession of the requisite amount of available funds, there would be no difficulty in having the road in operation to the city of Macon in eighteen months.

In our machinery, and transportation departments, we are gradually advancing towards the completion of a system commensurate with the ex-

tended business that will undoubtedly be attracted by our road. The works at the Spring Hill depot, comprising the erection of the requisite machine shops, engine houses, passenger houses, store houses, offices, &c., have progressed with less vigor than would have been desirable, in consequence of the difficulty of obtaining a supply of materials, and a sufficient force of mechanics during the summer season; no serious inconvenience has resulted from this circumstance.

In our motive power department, we have 5 locomotive engines, 4 of which are in good order, and one under repairs; 4 passenger cars, 13 close 8 wheel cars capable of stowing from 40 to 50 bales cotton each, 2 baggage cars and 8 open platform 8 wheel cars. It was supposed this would be sufficient to accomodate any amount of business that could reasonably be expected, during what may properly be called our first business season—while our road is only about half completed and has not yet approached within striking distance of the section of country from which we expect ultimately to derive our greatest business. We have, however, been obliged to keep every engine and car in constant requisition, for the transportation of merchandize from, and cotton to the city; and having been singularly fortunate in the regularity that our trains have run without accident, we have been able to do all or nearly all the business that has offered.

We are in daily expectation of the arrival from the north, of two additional engines, two 8 wheel passenger cars, and the requisite machinery for our shops.

Our mechanics will be kept constantly employed in the construction of freight cars, until we have a full complement for any emergency.

The effect of the road even at this incipient stage of its operations, on the trade and general prosperity of the city, is most manifest. Persons from remote counties, who have not visited the city before for years, have come here for their supplies. We have transported merchandize during the present fall for upwards of fifty different counties; and instances have occurred, when we have had in the same train, goods destined for thirty counties.

In confirmation of a remark in my last report relative to the healthiness of Savannah, is the fact, that amid the general prevalence of disease throughout a great portion of the southern cities, and in many parts of the country, during the past season; this city has enjoyed an entire exemption from any epidemic. No instance is known of a person having contracted disease by visiting the city from the country.

The present season has afforded abundant demonstration of the benefits that would result from the construction of the contemplated branch road to the city of Augusta. During the past three months, large quantities of merchandize have arrived here for that city—while the epidemic prevailed, wagoners could not be induced to go there from the head of our road. The goods were stored, and with the exception of a portion that have been shipped to Charleston to go up by the Hamburg road, are now in store here.

The unusual drought has cut off all communication by the river, and now that the sickness is abating in Augusta, and the fall business is opening, it is almost impossible to appreciate the sacrifices and derangement of business that must result from these circumstances.

The immense amount of business that would accrue to both cities furnish a most pressing inducement for the early commencement of the road in question.

I will close this communication with a statement of the business of our road for the three months ending 31st October.

	Passengers.		Freight.		Aggregate.	
	No.	Amount.	Dolls.	Cts.	Dolls.	Cts.
August,	747	\$1464 25	2108	77	3573	02
September,	688	1565 10	6278	49	7843	59
October,	875	2215 50	11844	99	14060	49
	2310	\$5244 85	\$20232	25	\$25477	10

I am sir, very respectfully, your obedient servant,
L. O. REYNOLDS, *Chief Engineer.*

THEORY OF THE STEAM-ENGINE.

(Continued from page 338.)

Section II.—Of the velocity of the piston under a given load.

In the 6th section of the preceding chapter, we have demonstrated that during all its action in the engine, the steam constantly remains at the state of maximum density for its temperature; and we have shown that, accordingly, when the steam passes, in the engine, from a certain volume M' to another volume M equally known, and that its pressure varies in consequence, and passes from the known pressure p' to another unknown pressure p , the pressure p may be determined by the following equation:

$$p = \frac{M'}{M} \left(\frac{n}{q} + p' \right) - \frac{n}{q} \quad \dots \quad (c)$$

This preliminary relation once established, in order to embrace immediately the most complete mode of action of the steam, we will suppose an engine working with expansion and condensation, and with any pressure whatever in the boiler. Then, to pass afterwards to unexpansive engines, or to those without condensation, it will suffice to make the proper suppressions and substitutions in the general equations.

From what is already known of the proposed theory, the relation we seek between the various data of the problem, will be deduced from two general conditions: the former expressing that the engine has attained an uniform motion, and consequently, that the quantity of work applied by the power is equal to the quantity of action developed by the resistance; the second, that there is necessarily, equality between the mass of steam expended by the cylinder, and the mass of steam generated in the boiler.

Let P be the total pressure of the steam in the boiler, and P' the pressure the same steam will have on arriving in the cylinder, a pressure which will always be less than P , except in a particular case, which we shall treat of shortly. The steam then will enter the cylinder at the pressure P' , and will continue to flow in with that pressure and to produce a corresponding effect, till the communication between the boiler and the cylinder is intercepted. The arrival of any new steam into the cylinder will then be stopped, but that which is already there will begin to dilate during the rest of the stroke of the piston, producing by its expansion a certain quantity of work, which will go to augment that already produced during the period of the admission of the steam.

P being, as has been said, the pressure of the steam in the boiler, and P' the pressure it will assume on reaching the cylinder before the expansion, let π be the pressure of that steam at any point of the expansion. At the same time let l be the total length of the stroke of the piston, l' the portion traversed at the moment when the expansion begins, and λ that which corresponds to the point where the steam has acquired the pressure π . Lastly, let a be the area of the piston, and c the clearance of the cylinder, that is to say, the vacant space which exists at each end of the cylinder, beyond the portion traversed by the piston, and which necessarily fills with steam at

every stroke; this space, including the adjoining passages, being represented by an equivalent length of the cylinder.

If the piston be taken at the moment when the portion of the stroke traversed is λ , and the pressure π , it will appear that if the piston traverse, moreover, an elementary space $d\lambda$, the elementary work produced in that motion will be $\pi a d\lambda$. But at the same time, the volume $a(l'+c)$, occupied by the steam before the expansion, will have become $a(\lambda+c)$. Hence, from the equation (c), indicated above, there will exist between the two corresponding pressures P' and π , the analogy

$$\pi = \left(\frac{n}{q} + P'\right) \frac{l'+c}{\lambda+c} - \frac{n}{q}.$$

Multiplying the two members of this equation by $a d\lambda$, we shall deduce

$$\pi a d\lambda = a(l'+c) \left(\frac{n}{q} + P'\right) \frac{d\lambda}{\lambda+c} - \frac{n}{q} a d\lambda.$$

This expression will give then the quantity of elementary work produced by the expansion, while the piston traverses the space $d\lambda$; and if the integral be taken between the limits l' and l , we shall have the total effect produced by the expansion of the steam, from the moment of its being intercepted to the end of the stroke: viz.

$$a(l'+c) \left(\frac{n}{q} + P'\right) \log \frac{l+c}{l'+c} - \frac{n}{q} a(l-l'),$$

an expression in which the logarithm is a hyperbolic one.

This quantity expressing the work performed in that portion of the stroke during which there was expansion, if we add to it the effect $P' a l'$ produced during the anterior part l' of the stroke, or before the beginning of the expansion, we shall have for the total work developed by the steam during the whole stroke of the piston,

$$a(l'+c) \left(\frac{n}{q} + P'\right) \left\{ \frac{l'}{l'+c} + \log \frac{l+c}{l'+c} \right\} - \frac{n}{q} a l.$$

But the engine being supposed to have attained uniform motion, the work developed by the mover must be equal to that developed by the resistance. Representing by R the total pressure exerted on the unit of surface of the piston by virtue of that resistance, or rather by virtue of the divers resistances which take place in the engine, the work it will have developed in one stroke, will have for its expression, $a R l$. We must therefore have the analogy

$$a(l'+c) \left(\frac{n}{q} + P'\right) \left\{ \frac{l'}{l'+c} + \log \frac{l+c}{l'+c} \right\} - \frac{n}{q} a l = R a l \quad (A),$$

which is the first general relation between the different data of the problem.

This equation expressing that the work developed by the power, is entirely found in the effect produced, it will be remarked that, for the analogy to take place, it is not necessary that the motion of the engine be strictly uniform. It may be composed of equal oscillations, beginning from zero of velocity, and returning to zero again; provided the successive oscillations be made in equal times, and that the changes of velocity take place by insensible degrees, so as to suffer no loss of *vis viva*.

It must be observed also, that, if in this expression we make $l'=l$, which amounts to supposing that the engine works without expansion, the equation reduces itself to $P'=R$; that is to say, the pressure of the steam in the cylinder will, in this case, be equal to the pressure of the resistance against the piston, as we have already demonstrated directly for unexpansive engines, of which we spoke in the first chapter.

We have just obtained the first general relation between the data and the incognita of the problem. Let us now seek a second analogy resulting from the equality between the production and the expenditure of the steam. If S be made to express the volume of water evaporated by the boiler in a unit of time, and transmitted to the cylinder, this volume on reaching the cylinder, transformed into steam at the pressure P' , will there become, from the relation already given (a),

$$\frac{S}{n+qP'}$$

This will then be the volume of steam, at the pressure P' , supplied by the boiler in a unit of time, in one minute for instance. On the other hand, $a(l+c)$ being the volume of the steam expended at each stroke of the piston, if there be K strokes per minute, the expense per minute will be $Ka(l+c)$. But expressing by v the velocity of the piston per minute,

we shall have also $v=Kl$; which gives $K=\frac{v}{l}$. Whence the above expenditure will be

$$\frac{va(l+c)}{l}$$

Since, then, there is an equality between the production and the expenditure of the steam, we shall have the equation

$$\frac{S}{n+qP'} = va \frac{l+c}{l}, \quad \dots \quad (B)$$

which is the second general relation between the data and the incognita of the problem.

Consequently, on eliminating P' from the two equations (A) and (B), we shall have as the final relation sought,

$$v = \frac{S}{a} \cdot \frac{1}{n+qR} \left\{ \frac{l}{l+c} + \log \frac{l+c}{l} \right\} \dots \quad (1)$$

In this equation the logarithm $\log \frac{l+c}{l}$ is a hyperbolic logarithm. As it is known that these logarithms are deduced from those of the tables, by multiplying the latter by the constant number 2.302585, or approximatively by 2.303, the term $\log \frac{l+c}{l}$ might, for practical purposes be replaced by $2.303 \log \frac{l+c}{l}$, in which \log would then express an ordinary logarithm.

But as tables of hyperbolic logarithms are found in several works, and as besides, we shall give in the sequel, a table which will dispense from all research on this head, we will not here make any change in the formulæ.

This equation is less simple than that which would be obtained in the same inquiry, by supposing the steam to preserve its temperature through the whole of its action in the engine; but that supposition, though producing often but slight differences in the definitive results of the calculations, is not really exact, since it is incontestable that the steam changes its pressure during the expansion, and that the experiments quoted above prove that it changes temperature in a manner exactly correspondent. The last formula which we have presented, has then the advantage of taking this important circumstance into account, and consequently of being more accurate in the applications. Besides, if in equation (1) the effect of the change of temperature be annulled, the formula becomes the same that we have presented in the first chapter, supposing the preservation of the temperature of the steam.

In effect, we have seen, from equation (a,) that after the steam has assumed in the engine the pressure R , the *absolute* volume of that steam, which corresponds to the volume of water S , is given by the relation

$$\frac{S}{n+qR}$$

On the contrary, when the steam is supposed to preserve its temperature, the volume varies in the inverse ratio of the pressure. If, then, we call m the relative volume of the steam generated at the pressure P of the boiler, a relative volume which can be known by the tables already given, it is clear that the absolute volume of the steam correspondent to the volume S of water will first be, under the pressure P , expressed by mS ; and that, in passing afterwards to the pressure R , this volume will change in the inverse ratio of the pressures, that is to say, will become

$$mS \frac{P}{R}.$$

Therefore to pass from one law to the other, we must write

$$\frac{S}{n+qR} = mS \frac{P}{R};$$

or, what comes to the same, we must, in the formulæ already obtained, make

$$n=0, \text{ and } \frac{1}{q} = mP.$$

Then the equation which gives the velocity, becomes

$$v = \frac{mPS}{aR} \left(\frac{l'}{l'+c} + \log \frac{l+c}{l'+c} \right);$$

which, for the case of unexpansive engines, or for $l'=l$, reduces itself to the following :

$$v = \frac{mPS}{aR} \cdot \frac{l}{l+c}$$

And this is precisely the equation we made use of in the first chapter, if only we neglect in it the clearance of the cylinder c .

The quantity R contained in equation (1,) is the total resisting pressure which takes place on the unit of surface of the piston in the motion. But this resisting pressure is evidently composed of three parts, namely, the resistance arising from the motion of the load, which we will call r ; that arising from the friction proper to the engine, which we will express by $(f+\delta r)$, calling f the friction of the engine unloaded, and δ the augmentation of that friction per unit of the load r ; and finally the pressure which may subsist on the face of the piston opposed to the arrival of the steam, which we will represent by p ; the latter quantity p expressing the atmospheric pressure, when the engine is without condensation, or only the pressure of condensation in the cylinder, when the engine is a condensing one. The quantities r , f , p and δ , are besides, as well as R , referred to the unit of surface of the piston.

(To be continued.)

The Menai Bridge is undergoing a complete repair, having suffered considerable damage in the storm last winter. Government has granted 8,000*l.*, but this is by no means sufficient.